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INTENSIVE EVALUATION OF WESTERN SPRUCE BUDWORM OUTBREAK IN NORTH-CENTRAL WASHINGTON

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INTRODUCTION

The western spruce budworm (*Choristoneura occidentalis* Freeman) has been present in outbreak numbers in the forests of north-central Washington since 1970. The area with visible budworm defoliation increased from 18,000 acres in 1971 to over 1,200,000 acres in the fall of 1977. Most of this defoliation occurred in Douglas-fir and true fir stands located on the Wenatchee and Okanogan National Forests and in the North Cascades National Park.

The Forest Service, in cooperation with the State of Washington, conducted chemical control programs in 1976 (1) and 1977 (2). Another control operation was proposed for the summer of 1978 (3), but decision was made to defer this chemical treatment until the summer of 1979 (4).

Postponement of the control action presented an opportunity to check the validity of assumptions and predictions made in the Draft Environmental Impact Statement (3) and to determine the adequacy of the methods used in making predictions.

This report compares the number of budworm larvae present in the spring of 1978 and the defoliation they caused with the number and damage predicted to occur from an egg mass survey made in the fall of 1977, as described in the Spruce Budworm Draft Environmental Statement (3).

Budworm larval counts and degree of defoliation in treated and untreated areas are compared to measure the effectiveness of the Sevin 4 oil treatments made in 1976 and 1977.

Results are given of a survey made in an attempt to determine the percentage of egg mass cases that remain on the host tree's foliage for more than one year.

A research note, in cooperation with Dr. T. Torgersen, of the Pacific Northwest Forest and Range Experiment Station, will be published covering data collected on the composition of parasites present and their density in Seven 4 oil-treated and untreated areas.

BUDWORM POPULATION PREDICTIONS

Objective - Eleven budworm-infested areas were recommended for chemical treatment in 1978. Maps and descriptions of each area were presented in the Draft Environmental Statement (3) and projections made as to the number of budworm larvae that would be present in the buds in 1978. These surveys were conducted during the summer of 1978 to determine the accuracy of these predictions.

Procedures - Five of the 11 areas recommended in the E.I.S. for chemical treatment were selected at random for larval population sampling. In each area, 26 plots were established, each plot consisting of 3 host trees that could be sampled at midcrown with a 16-foot pruning pole. Plots were flagged on the ground and recorded on a map, so they could be resampled for defoliation at a later date. Collections were made in June after the buds had flushed when the majority of the larvae were either in the third or fourth instar.

Two bud-bearing branches, 15 inches long, were clipped from the midcrown of each tree, labeled, then placed in a plastic bag for transportation to the laboratory for examination. At the laboratory, all live budworm larvae were counted and the number of new growth tips (1978 buds) recorded. Budworm density per 100 growth tips was computed. Those areas with populations greater than 12 were expected to receive moderate defoliation according to Carolin and Coulter's work (5).

Results - Budworm counts were lower than predicted in the draft E.I.S. (3) as larval counts exceeded 12 per 100 buds in only 1 of the 5 areas surveyed (Table 1).

Table 1.--Budworm larval counts on 5 areas that had been proposed for control compared with the predicted populations levels in the Draft Environmental Statement (3).

Unit	1977 Egg Count	Budworm Population Per 100 Growth Tips	
		Predicated	Actual
Robinson	5.3	16.3	16.9
Cedar	4.0	12.9	10.1
Summit	4.4	13.9	9.1
Cle Elum	5.9	17.8	4.6
Lookout	6.9	20.4	3.8

Discussion - Carolin and Coulter (5) based their predictions of budworm population and resulting defoliation on the number of larvae found in the opening buds. There was an abnormally hot dry period during late May of 1978 and the buds had flushed with 1 or 2 inches of new foliage present at the time the collections were made. Exposure to the weather and predators after the buds had opened may have caused a reduction in the budworm populations before collections were completed. This possibility is strengthened by the results of defoliation occurring on the same trees.

BUDWORM DEFOLIATION PREDICTIONS

Objectives - This survey was made to determine if moderate defoliation did occur and, if not, what the degree of foliage loss was. The 1978 Draft Environmental Statement predicted that moderate defoliation would occur in all 11 areas recommended for chemical treatment. Moderate defoliation is the removal by budworm larval feeding of 25 to 50 percent of the current year's foliage (Table 2). This survey was made to determine if moderate defoliation did occur and, if not, what the degree of foliage loss was.

Table 2.--Standard categories of defoliation on Douglas-fir

Percent defoliation	Defoliation category
0 - 15	Very light
16 - 25	Light
26 - 50	Moderate
51 - 100	Heavy

Procedures - Defoliation surveys were made on the same 5 areas used in the previous evaluation of budworm populations. Examinations were made after all budworm feeding had been completed for the year and were on the same plots and trees used in the population evaluation. Four 20-inch branches were pruned from the midcrown of each tree and the 25 most distal shoots examined for degree of defoliation. Defoliation for each shoot was recorded to the nearest 10 percent with unopened buds mined by budworm feeding tallied at 100 percent. The mean degree of defoliation for each area was determined (Table 3).

Results - Defoliation on 3 of the 5 areas surveyed had the degree of damage predicted in the Environmental S atement. One area with 58 percent defoliation was greater than predicted and rated as heavy. The remaining area classed as light with 24 percent defoliation missed the moderate category by 1 percentage point.

The defoliation data when compared with the population counts made in Study I indicate that defoliation should have been less than what occurred. There are 2 possible reasons for this--(1) population counts may have been made too late, e.g., after the buds had flushed or (2) fewer budworms will give a greater volume of defoliation than predicted by Carolin and Coulter (5).

Table 3.--Actual western spruce budworm defoliation on 5 areas proposed for control, compared with predicted defoliation levels in the 1978 Draft Environmental Statement.

Proposed Unit	DEFOLIATION CATEGORY		Percent Defoliation
	Predicted	Actual	
Robinson	Moderate	Moderate	49
Cedar	Moderate	Moderate	34
Summit	Moderate	Heavy	58
Cle Elum	Moderate	Light	24
Lookout	Moderate	Moderate	42

EVALUATION OF CONTROL EFFECTIVENESS

Objective - Determine if the reduction in budworm populations obtained in 1976 and 1977 on areas treated with Sevin 4 Oil was maintained through the 1978 season.

Postspray budworm counts ten days after treatment in areas sprayed with Sevin 4 Oil indicated that budworm populations had been reduced to a level below two larvae or one pupae per hundred buds, a level where minimal defoliation should occur the following year. It has not yet been determined how long the treatment will remain effective due to moth flights from adjacent untreated areas or from a buildup of the low residual budworm population within the control area.

Procedures - Budworm populations on 2 successfully treated areas on the Winthrop District of the Okanogan National Forest were surveyed for comparison with untreated populations in adjacent areas. Goat Creek Unit treated in 1976 and the Mazama Unit treated in 1977 were the areas selected. Population plots along the upper Methow River used as checks in 1976 and 1977 were again used as checks.

Budworm sampling was timed to coincide as nearly as possible with the stage of development (50 percent in the 5th instar plus 14 days) that was sampled in 1976 and 1977. Population sampling methods were the same as used in previous years and consisted of clipping 4 midcrown branches from each of 3 trees in the 26 plots in each area. In the laboratory, all new growth tips or buds were counted and live budworms, either larvae or pupae, were recorded.

Budworm populations per hundred growth tips was computed and these counts compared with the number present two weeks after completion of the 1976 and 1977 control programs. Populations in the 1977 treated areas were compared with those in the 1976 treated areas and both of these areas were compared with the untreated adjacent check plots.

Results - The first goal in determining the effectiveness of the 1976 and 1977 budworm control projects was a reduction in the budworm population to less than 3 larvae or 1 pupae per 100 shoots 14 days after insecticide application. This population reduction was obtained on all the Sevin 4 Oil treated areas and the present study indicates that the population has remained below this level. Meanwhile, the budworm population on the untreated check plots has continued at a high level although reduced from the numbers present in 1976 and 1977 (Table 4).

Table 4.--Budworm populations on areas treated with Sevin 4 Oil 14 days after treatment compared with 1978 populations at the same stage of development.

Area	Treatment	BUDWORM POPULATION PER 100 BUDS		
		1976	1977	1978
Goat Peak	Sevin 4 Oil 1976	1.1	---	0.07
Mazama	Sevin 4 Oil 1977	---	0.5	0.05
Methow	None	14.2	14.6	6.4

There was a significant difference in populations on the treated areas compared with the untreated areas with larvae on the untreated trees averaging more than 6 per 100 tips compared with less than one-tenth of a budworm per 100 tips on both the '76 and '77 treated areas. The difference between the .05 budworm per 100 buds on the 1977 treated area was not significantly less than the .07 on the the 1976 treated area.

No budworm were found in collections from 80 percent of the 1977 treated plots and 77 percent of the 1976 treated plots, while budworms were found on 96 percent of the collections from untreated plots (Table 6).

This study indicates that there has been no buildup in budworm populations in areas successfully treated with Sevin 4 Oil in 1976 or 1977. During this period, there has been a slight reduction in the population in the surrounding area but migration of this population into the treated area has not occurred.

Table 6.--Budworm populations per 100 growth tips during the summer of 1978 on areas treated with Sevin 4 Oil during 1976 or 1977 and on adjacent untreated check plots.

Plot No.	Treated 1976	Treated 1977	Untreated Checks
1	0.34	0	3.59
2	0	0	10.9
3	0	0	2.87
4	0.17	0	0.35
5	0.12	0	14.43
6	0	0	13.0
7	0	0.13	2.94
8	0	0.27	0.77
9	0	0.39	3.78
10	0	0	8.81
11	0	0	8.92
12	0.14	0	19.32
13	0	0	4.42
14	0	0	22.87
15	0	0	0.26
16	0	0.56	0.60
17	0	0	1.91
18	0	0	6.18
19	0	0	2.50
20	0	0	7.22
21	0	0.16	11.11
22	0	0	6.77
23	0	0	4.60
24	0.88	0	6.26
25	0	0	0
26	0.23	0	1.42

Objective - During budworm egg surveys, an entomologist using experience to separate what he believes are old egg mass cases from the current year or new egg cases. The question has arisen as to the degree of persistence of the old egg mass cases on the foliage and what percentage, if any, actually remain for a year or more.

Buffam and Carolin (6) presented data indicating that budworm infestation trends could be determined with only one year's sampling by using old egg mass counts to represent the previous year's new egg masses. Later, Terrell (7) contended that old egg masses do not represent an accurate index of the preceding year's egg mass population due to the loss of many old egg masses during the year.

Procedure - During the fall of 1977, over 800 egg mass survey plots were sampled on the Okanogan National Forest and North Cascades National Park. These plots were tagged in the field and their locations recorded. For each plot, the new and old egg mass cases per 1,000 square inches of foliage were determined. Twenty-six of these plots which had new egg mass counts of 5 or greater were relocated and sampled during early July 1978, before the 1978 moth flights had started to see if egg mass cases were still present.

Population sampling methods used were the same as those used in 1977. This method consisted of pruning two 30-inch branch ends from the midcrown of each of three trees in a plot. In the field, the area of foliage collected was determined. In the laboratory, the foliage was examined by the same personnel who did the previous fall's examination and all egg mass cases were removed and counted. Egg mass cases per 1,000 square inches of foliage were determined and compared with the counts from the fall of 1977 to see if there was a correlation between numbers retained.

Table 7.--Western spruce budworm egg mass case counts on the Okanogan National Forest and North Cascades National Park during the fall of 1977 and during July 1978 prior to moth flight.

Plot No.	EGG MASSES PER 1000 SQUARE INCHES OF FOLIAGE FALL OF 1977 New Cases	FALL OF 1977 Old & New Cases	JULY 1978 Old Cases	Percent Retained
3004	21.9	45.9	2.9	6.3
3008	5.2	6.3	11.4	180.9
3412	3.1	4.1	1.4	34.1
4611	4.0	8.5	24.8	291.7
4612	5.1	11.3	6.9	61.0
4702	3.3	5.7	4.7	82.4
4703	2.3	4.0	3.3	82.5
4704	30.9	53.1	6.5	12.2
4705	10.5	14.8	19.4	131.0
4707	5.0	19.5	1.0	5.1
4708	5.7	11.4	13.1	114.9
4709	10.9	19.9	1.2	6.0
4710	3.5	6.6	4.7	71.2
4931	6.0	11.0	8.4	74.5
4932	10.5	14.7	10.6	72.1
6422	6.4	10.0	0	0
6424	13.3	14.7	6.5	44.2
6832	4.0	12.5	0.9	7.2
6930	4.2	6.0	16.3	271.6
7301	4.4	9.5	6.5	68.4
7405	6.3	9.1	4.5	49.4
7407	5.4	13.7	3.5	25.5
7408	14.1	27.2	3.4	12.5
7824	5.1	6.8	6.7	98.5
7825	4.0	11.9	11.2	94.1
7929	9.8	11.3	1.6	14.1

$y = -0.085x + 8.19$ $R = -0.16$ where y = old (1978) x = new+old (1977

$y = 0.025x + 6.69$ $R = 0.08$ where y = old (1978) x = new (1977)

Results - There was no correlation between the total number of new and old masses counted in the fall of 1977 and those retained until July of the following year. The percentage of masses present in July ranged from 0 to 180 percent of those counted in the fall, 5 of the 26 plots sampled had more egg masses counted than were present in the fall.

Wind, rain, hail and other elements of the weather affect the retention rate of egg mass cases. Other insects and birds are predators of eggs and destroy these cases. Since the exposure of each egg case is varied as to its location on the tree, exposure of the stand, density of predators, as well as varied as the weather that may occur in each area, it is doubtful if there is a consistent degree of retention from location to location or from year to year.

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(3) USDA Cooperative western spruce budworm draft environmental statement. USDA, Forest Service, Pacific Northwest Region, Portland. February 1978.

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